Ablation: Lung and kidney

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Introduction

Ablation therapy has been becoming an accepted treatment modality for tumors located not only in the liver but also in the various organs such as lung, kidney, bone, adrenal gland, thyroid gland, and so on. Ablation therapy is a minimally invasive treatment and the effects on normal tissue are limited. Therefore, there are several advantages in this treatment when used in the treatment of lung and kidney malignancies.

In this lecture, we will discuss the indication, technique, complications, and current clinical results of ablation therapy in the treatment of lung and kidney malignancies.

Lung ablation

Lung cancer is the most common malignancy and the leading cause of cancer-related mortality worldwide [**1**]. The lung is also the most frequent sites of metastasis from various types of malignant neoplasms [**2,3**]. Surgery is the standard treatment of early stage non-small cell lung cancer (NSCLC) or oligo-metastatic lung cancer [**4,5**]. Nevertheless, some patients cannot undergo surgery due to poor respiratory function, advanced age, or multiple comorbidities. Stereotactic body radiotherapy (SBRT) and chemotherapy are useful alternative in inoperable patients; however, these treatments modalities are often associated with significant adverse events and long duration of therapy.

Currently, image-guided ablation including radiofrequency ablation (RFA), microwave ablation (MWA), cryoablation, and irreversible electroporation (IRE) have been used as the useful therapeutic option in lung malignancies. Of these, RFA has been the primary technique and the utility of RFA in the treatment of lung malignancies are reported in numerous publications with a large volume of data.

Indication for lung RFA

The ideal indication for lung RFA treatment are the following: 1) lung tumor considered treatable using RFA; 2) complete control of primary tumor, no extrapulmonary disease; 3) peripheral capillary oxygen saturation level of 90% or higher; 4) Eastern Cooperative Oncology Group performance status of 0 or 1.

Technique

Lung RFA is usually performed under local anesthesia with computed tomography (CT) guidance. The application of CT fluoroscopy makes the procedure shorter and

safer. The straight internally cooled electrode or multi-tined expandable electrode are used. The ablation area is presented as ground glass opacity in CT [**6**]. If the ablation zone does not cover the tumor, overlapping ablation may be applied until the ablation zone includes the entire tumor.

Complications

Although the lung RFA is considered as a minimally invasive procedure with low mortality rate (<1%), it can be associated with various complications. The major and minor complication rates after lung RFA have been reported to be 6–13% and 28–40%, respectively [**7-9**]. Pneumothorax is the most common complication after lung RFA. Emphysema, lack of history of ipsilateral lung surgery, multiple tumors, advanced age, and traversal of major fissure were the significantly associated risk factor for post-ablation pneumothorax [**9**]. Although the frequency is limited, potentially fatal complications such as massive hemorrhage [**10,11**], pulmonary artery pseudoaneurysm [28, 29], and systemic air embolism [**12,13**] are also reported.

Outcomes

The local tumor progression rate after lung RFA has been reported to be 18–53% at 3 years [**7,8**]. Tumor size and location are important factors those associated with local tumor progression after lung RFA.

The 1-, 3-, and 5-year overall survival following lung RFA have been reported to be 83–97%, 40–73%, and 25–61% in patients with NSCLC [**7,14,15**]. Tumor size, tumor stage, and histopathology were significant predictors of survival in patients with NSCLC [**8,16**]. For metastatic lung cancer, the 1-, 3-, and 5-year survival rates after RFA have been reported to be 84–88%, 46–60%, and 45–52%, respectively [**17-20**]. The significant prognostic factors include tumor size, number of metastases, and existence of extrapulmonary disease [**20**].

Kidney ablation

Partial or radical nephrectomies are the gold standards for the treatment of renal cell carcinoma (RCC) [**21,22**]. However, some patients are not suitable for nephrectomy because of surgical risks, reduced renal function, multiple tumors, and so on. Local ablation therapies such as cryoablation and RFA are minimally invasive treatment, and the preservability of renal function is excellent. Therefore, ablation therapy can be used as a useful alternative in patients not suitable for nephrectomy.

Procedures

Renal ablation is usually performed under local anesthesia with conscious sedation. CT is usually used as an imaging guidance. MRI is also useful especially in case of cryoablation. Because of the high blood flow of renal tissue, it is sometimes difficult to

achieve complete ablation by single ablation. In such case, multiple overlapping ablations are required to achieve complete ablation. Selective renal artery embolization is useful to increase the local efficacy and reduce the hemorrhagic complications. However, renal artery embolization has a risk to deteriorate renal function. Therefore, the indication of renal artery embolization should be determined carefully. Renal tumor is sometimes located close to the adjacent organs such as ureter, GI tracts, and pancreas. Therefore, appropriate preparations such as ureter catheter placement and hydrodisscection is sometimes required to avoid the collateral damages.

Complications

Ablation therapy is a minimally invasive treatment. Therefore, the frequency and the severity of complications after ablation is lower than those after nephrectomy (**23,24**). The major complication rates after RFA and cryoablation are reported to be 4-5% and 5-8%, respectively (25,26). Although the incidences of complications are similar between RFA and cryoablation, type of complications are slightly different. Hemorrhagic complications are more frequently occur after cryoablation (2-7%), while neural injury (1-4%) and urinary injury (2-3%) are more after RFA (25,26).

Clinical outcomes

The 5- and 10-year disease-free survival rates after RFA in patients with T1a RCC have been reported to be 87-98% and 92-94%, respectively. Some retrospective and meta-analysis suggests that the oncologic outcomes after RFA in patients with T1a RCCs are comparable to those of nephrectomy (**27-30**). The 5- and 10-year disease-free survival rates after RFA in patients with T1b RCC have been reported to be 81-88% and 50-88%, respectively. Those results are almost similar or a little bit worse than those of nephrectomy (**27,29,31,32**).

Although the available survival data about percutaneous cryoablation is still limited, Georgeades et al. reported that the 5-year RCC-related survival after percutaneous cryoablation was 100% in both T1a and T1b RCC patients (**33**). Caputo et al. reported that the survival results of percutaneous cryoablation was comparable to nephrectomy, although the local recurrence after cryoablation was more frequent than those after nephrectomy (**34**). However, there are still no randomized controlled trials of high quality comparing the safety and oncological efficacy between ablation therapy and nephrectomy; therefore, more high quality data with longer follow-up will be needed to establish a firm position in the treatment of RCCs.

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